CLAIMS

What is claimed is:

1. A method of measuring an overlay error that is corrected for process variations, said method comprising:

producing an incomplete overlay pattern, said incomplete overlay pattern having a plurality of measurement locations, each location having a bottom diffraction grating;

illuminating each of said plurality of measurement locations of said incomplete overlay pattern with incident radiation that reacts with said diffraction gratings;

detecting the radiation from said plurality of measurement locations after reacting with said diffraction gratings;

completing said overlay pattern, said completed overlay pattern having said plurality of measurement locations, each location having said bottom diffraction grating and a top diffracting grating that overlies said bottom diffraction grating and has a designed in offset from said bottom diffraction grating;

illuminating each of said plurality of measurement locations of said completed overlay pattern with incident radiation that reacts with said diffraction gratings;

detecting the radiation from said plurality of measurement locations after reacting with said diffraction gratings; and

using the detected radiation from said plurality of measurement locations of said incomplete overlay pattern and the detected radiation from said plurality of measurement locations of said completed overlay pattern to determine the overlay error.

2. The method of Claim 1, wherein using the detected radiation from said plurality of measurement locations of said incomplete overlay pattern and the detected radiation from said plurality of measurement locations of said completed overlay pattern to determine the overlay error comprises:

generating a plurality of ratios of differential spectra from measurement locations of said incomplete overlay pattern;

generating a plurality of differential spectra from measurement locations of said completed overlay pattern;

using said plurality of ratios and said plurality of differential spectra from measurement locations of said completed overlay pattern to determine the overlay error.

3. The method of Claim 2, wherein using said plurality of ratios and said plurality of differential spectra comprises directly solving for the overlay error based on said plurality of ratios and said plurality of differential spectra and the difference in the designed in offset at two measurement locations.

4. The method of Claim 3, wherein two of said plurality of measurement locations of said completed overlay pattern have the same designed in offset.

5. The method of Claim 4, wherein:

generating a plurality of ratios of differential spectra from measurement locations of said incomplete overlay pattern comprises:

generating a first ratio of differential spectra from measurement locations of said incomplete overlay pattern;

generating a second ratio of differential spectra from measurement locations of said incomplete overlay pattern;

generating a plurality of differential spectra from measurement locations of said completed overlay pattern comprises:

generating a first differential spectra from measurement locations of said completed overlay pattern;

generating a second differential spectra from measurement locations of said completed overlay pattern;

generating a third differential spectra from measurement locations of said completed overlay pattern; and

using said plurality of ratios and said plurality of differential spectra from measurement locations of said completed overlay pattern to determine the overlay error comprises:

determining the overlay error based on the product of said first differential spectra and said first ratio minus the second differential spectra divided by said third

differential spectra minus the product of said first differential spectra and said second ratio.

6. The method of Claim 4, wherein there are at least four measurement locations.

7. The method of Claim 6, wherein a first measurement location and a second measurement location have designed in offsets of the same magnitude in opposite directions.

8. The method of Claim 7, wherein said first measurement location and a third measurement location have designed in offsets of the same magnitude in the same direction.

9. The method of Claim 2, wherein using said plurality of ratios and said plurality of differential spectra comprises curve fitting.

10. The method of Claim 9, further comprising:

generating a second plurality of differential spectra from measurement locations of said completed overlay pattern;

using said plurality of ratios and said second plurality of differential spectra to determine the spectral contribution from the designed in offset;

determining the spectral contribution from processing; and

using the determined spectral contribution from processing and the determined spectral contribution from the designed in offset with said plurality of differential spectra to curve fit for the overlay error.

11. The method of Claim 9, wherein the spectral contributions from the designed in offset and the spectral contributions from processing are held to be orthogonal, and wherein the curve fitting is done for a plurality of wavelengths where the overlay error is identical for each of said plurality of wavelength.

12. A method of determining the overlay error that is corrected for process variations in an overlay pattern having a plurality of measurement locations, each measurement location having a bottom diffraction grating and a top diffraction grating, each top diffraction grating overlies a corresponding bottom diffraction grating and has a designed in offset, wherein a plurality of measurement locations have different designed in offsets, said method comprising:

generating a first plurality of differential spectra, the spectra being measured from measurement locations of said overlay pattern prior to producing said top diffraction gratings;

generating a second plurality of differential spectra, the spectra being measured from measurement locations of said overlay pattern after producing said top diffraction gratings; and

using said first plurality of differential spectra and said second plurality of differential spectra to determine the overlay error.

13. The method of Claim 12, further comprising:

generating a plurality of ratios of differential spectra using said first plurality of differential spectra; and

wherein said using said first plurality of differential spectra comprises using said plurality of ratios of differential spectra.

14. The method of Claim 13, wherein using said plurality of ratios and said plurality of differential spectra comprises directly solving for the overlay error based on said plurality of ratios and said plurality of differential spectra and the difference in the designed in offset at two measurement locations.

15. The method of Claim 14, wherein:

generating a plurality of ratios of differential spectra comprises generating a first ratio of differential spectra and generating a second ratio of differential spectra;

generating a plurality of differential spectra comprises generating a first differential spectra, generating a second differential spectra, and generating a third differential spectra; and

using said plurality of ratios and said plurality of differential spectra to determine the overlay error comprises determining the overlay error based on the product of said first differential spectra and said first ratio minus the second differential spectra divided by said third differential spectra minus the product of said first differential spectra and said second ratio.

16. The method of Claim 13, wherein using said plurality of ratios and said plurality of differential spectra comprises curve fitting.

17. The method of Claim 16, further comprising:

generating a second plurality of differential spectra, the spectra being measured from measurement locations of said overlay pattern after producing said top diffraction gratings;

using said plurality of ratios and said second plurality of differential spectra to determine the spectral contribution from the designed in offset;

determining the spectral contribution from processing; and

using the determined spectral contribution from processing and the determined spectral contribution from the designed in offset with said plurality of differential spectra to curve fit for the overlay error.

18. The method of Claim 16, wherein the spectral contributions from the designed in offset and the spectral contributions from processing are held to be orthogonal, and wherein the curve fitting is done for a plurality of wavelengths where the overlay error is identical for each of said plurality of wavelength.

19. An apparatus for determining the overlay error that is corrected for process variations in an overlay pattern having a plurality of measurement locations, each measurement location having a bottom diffraction grating and a top diffraction grating, each top diffraction grating overlies a corresponding bottom diffraction grating and has a designed in offset, wherein a

plurality of measurement locations have different designed in offsets, said apparatus comprising:

a radiation source for producing radiation to be incident on said plurality of measurement locations of said overlay pattern;

a detector for detecting the spectra after said radiation interacts with said measurement locations of overlay pattern; and

a computer and a computer-usable medium having computer-readable program code embodied therein for causing said computer to perform the acts of:

generating a first plurality of differential spectra, the spectra being detected from measurement locations of said overlay pattern prior to producing said top diffraction gratings;

generating a second plurality of differential spectra, the spectra being detected from measurement locations of said overlay pattern after producing said top diffraction gratings; and

using said first plurality of differential spectra and said second plurality of differential spectra to determine the overlay error.

20. The apparatus of Claim 19, wherein said computer-readable program code for causes said computer to perform the acts of:

generating a plurality of ratios of differential spectra using said first plurality of differential spectra; and

wherein said using said first plurality of differential spectra comprises using said plurality of ratios of differential spectra.

21. The apparatus of Claim 20, wherein using said plurality of ratios and said plurality of differential spectra comprises directly solving for the overlay error based on said plurality of ratios and said plurality of differential spectra and the difference in the designed in offset at two measurement locations.

22. The apparatus of Claim 20, wherein using said plurality of ratios and said plurality of differential spectra comprises curve fitting.

23. A method comprising:

providing an overlay pattern having a plurality of measurement locations, each measurement location includes a bottom diffraction grating and a top diffracting grating that overlies the bottom diffraction grating and has a designed in offset from the bottom diffraction grating;

illuminating each of the plurality of measurement locations of the overlay pattern with incident radiation that reacts with the diffraction gratings;

detecting the radiation from the measurement locations after reacting with the diffraction gratings;

determining the overlay error between the bottom diffraction gratings and the top diffraction gratings using the detected radiation from the measurement locations from the overlay pattern; and

correcting the overlay error for effects of local process variations created during processing of the overlay pattern using the detected radiation from at least one pair of the measurement locations from the overlay pattern.

24. The method of Claim 23, further comprising:

providing the overlay pattern having the plurality of measurement locations prior to depositing the top diffraction gratings over the bottom diffraction gratings, such that the overlay pattern is incomplete and each measurement location of the incomplete overlay pattern has a bottom diffraction grating;

illuminating each of the plurality of measurement locations of the incomplete overlay pattern with incident radiation that reacts with the bottom diffraction gratings; and

detecting the radiation from said plurality of measurement locations of the incomplete overlay pattern;

wherein determining the overlay error uses the detected radiation from the measurement locations from the incomplete overlay pattern and the detected radiation from the measurement locations from the overlay pattern;

wherein correcting the overlay error for effects of local process variations uses the detected radiation from at least one pair of the measurement locations from the overlay pattern and the detected radiation from the incomplete overlay pattern.

25. The method of Claim 24, wherein using the detected radiation from the measurement locations of the incomplete overlay pattern and the detected radiation from the measurement locations of the completed overlay pattern to determine the overlay error comprises:

generating a plurality of ratios of differential spectra from measurement locations of the incomplete overlay pattern;

generating a plurality of differential spectra from measurement locations of the completed overlay pattern;

using said plurality of ratios and said plurality of differential spectra to determine the overlay error.

26. The method of Claim 25 wherein using said plurality of ratios and said plurality of differential spectra comprises directly solving for the overlay error based on said plurality of ratios and said plurality of differential spectra.

27. The method of Claim 25, wherein using said plurality of ratios and said plurality of differential spectra comprises curve fitting.

28. The method of Claim 23, wherein correcting the overlay error for effects of local process variations created during processing of the overlay pattern is performed while determining the overlay error.

29. The method of Claim 23, wherein:

the overlay pattern has at least four measurement locations;

at least a first pair of the measurement locations have a designed in offset of a first magnitude and at least a second pair of the measurement locations have a designed in offset of a second magnitude; and

correcting the overlay error for effects of local process variations created during processing of the overlay pattern uses the detected radiation from the first pair of measurement locations that have the designed in offset of the first magnitude.

30. The method of Claim 29, wherein the first pair of measurement locations have a designed in offset of the first magnitude in the same direction and the second pair of measurement locations have a designed in offset of the second magnitude in opposite directions.

31. The method of Claim 29, wherein correcting the overlay error for effects of local process variations created during processing of the overlay pattern further uses the detected radiation from the second pair of measurement locations that have the designed in offset of the second magnitude.

32. The method of Claim 31, wherein the first pair of measurement locations have a designed in offset of the first magnitude in opposite directions and the second pair of measurement locations have a designed in offset of the second magnitude in opposite directions.

33. A method comprising:

providing an overlay pattern having at least four measurement locations, each measurement location having a bottom diffraction grating and a top diffracting grating that overlies the bottom diffraction grating and has a designed in offset from the bottom diffraction grating, at least two pairs of the measurement locations have the same magnitude designed in offset;

illuminating each of the measurement locations of the overlay pattern with incident radiation that reacts with the diffraction gratings;

detecting the radiation from the measurement locations after reacting with the diffraction gratings;

determining the overlay error between the bottom diffraction gratings and the top diffraction gratings using the detected radiation from the measurement locations; and

correcting the overlay error for effects of local process variations created during processing of the overlay pattern using the detected radiation from at least one pair of the measurement locations from the overlay pattern.

34. The method of Claim 33, wherein at least two of the measurement locations have the same magnitude designed in offset in opposite directions and at least two measurement locations have the same magnitude designed in offset in the same direction.

35. The method of Claim 33, wherein a first pair of the measurement locations have a first magnitude designed in offset in opposite directions and a second pair of the measurement locations have a second magnitude designed in offset in opposite directions, wherein the first magnitude is different than the second magnitude.

36. The method of Claim 33, wherein correcting the overlay error for effects of local process variations created during processing of the overlay pattern is performed while determining the overlay error.